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REVIEW OF THE LATEST TECHNOLOGY IN CARTOGRAPHIC DATA ACQUISITION, MANIPULATION, STORAGE AND PRESENTATION, WITH SPECIAL EMPHASIS ON POTENTIAL APPLICATIONS IN DEVELOPING COUNTRIES: AUTOMATED MAPPING PROJECTS: DEVELOPMENT AND APPLICATION OF DIGITAL CARTOGRAPHIC DATABASES, INCLUDING DIGITAL TERRAIN MODELLING

Cartography at the Brazilian Institute of Geography and Statistics (IBGE)

Paper submitted by Brazil

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ABSTRACT

The Brazilian Institute of Geography and Statistics (IBGE) , a governamental institution of the Repuplic Presidency Planning Ministry, through the Cartographic Department of Earth Sciencie Management, is the integrant Agency of the National Cartographic System, responsible for the National Mapping in Geographic scales (millionth international sheets (CIM) - 1:1.000.000 ; Brazil series sheets - 1:2.500.000, 1:500.000, 1:10.000.000; Regional sheets, States sheets and Atlas) and topographic scales (1:250.000, 1:100.000, 1:50.000 and 1:25.000).

The major objective in changing the approach of cartographic data is the formation of a new cartographic database (Cartographic Database), so that it can be the georeferences database support to emergent Geographic Information Systems, as well as helping the establishment of cartographic positives through computerized ways.

This paper will show you how the Cartographic Department of the IBGE has planned and has been planning this new way of cartographic data production as well as, lauching the products available in digital media.

I) INTRODUCTION

The **Brazilian Institute** of **Geography** and **Statistics**, was set up in 1934, through the necessity of linkage of some cartographic services and government statistics requirements. Nowadays, the **IBGE** is in charge of The National Statistics System (SEN) and The National Cartographic System (SCN) as well. Therefore, the IBGE focus its attention on data production. The two main areas are: **Statistics** and **Earth Science**.

In Brazil, the linkage of these two sciences at the same company, helps the IBGE to make up an overall portrait of the country and represents an easy and cheap way of data production.

In the development of the portrait of Brazil, the IBGE uses three basic languages : **Statistical**, **Geographic** and **Cartographic**.

The cartographic language is the beginning and the end of the process of production of Brazil's portrait. At first the company is responsible for the database construction in which the information is based and, at the end, is also responsible for geographic and statistical patterns.

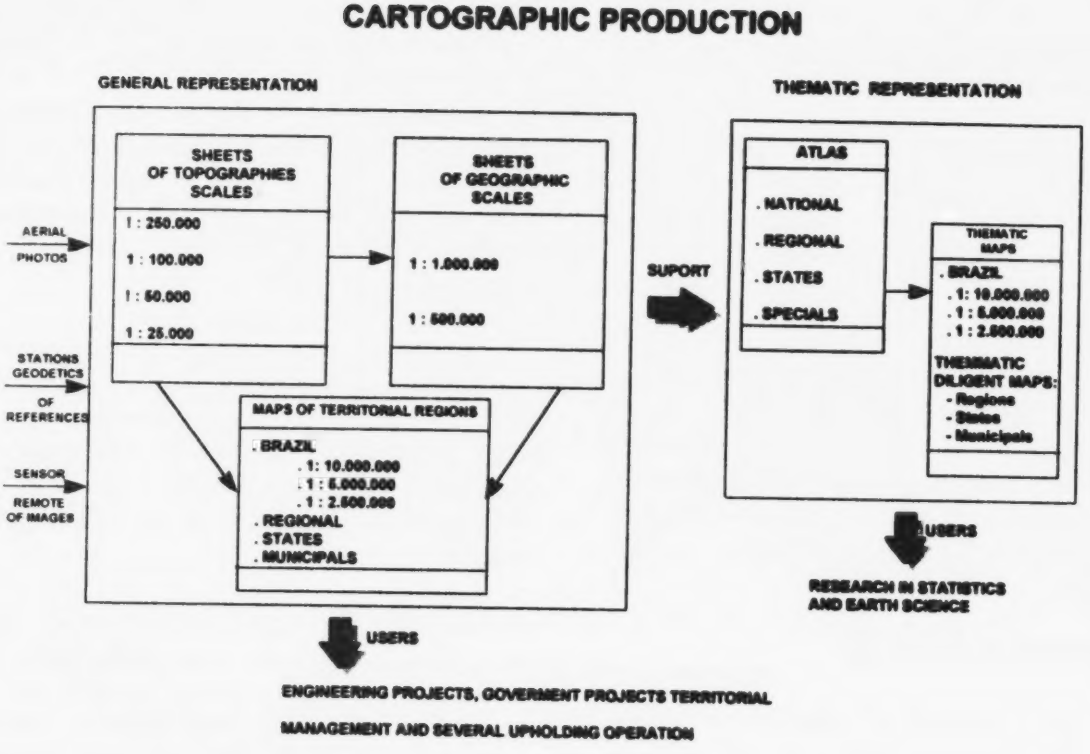
The IBGE is responsible for the systematic mapping, in geographic scales of the Brazilian territory and, co-responsible with The Geographic Service of Brazil Army Ministry, for systematic mapping in topographic scales.

The major areas are :

. The topographic mapping.
. The mapping of the territorial regions.
. The thematic mapping.

II) THE TOPOGRAPHIC MAPPING :

The topographic mapping stands for the Brazilian territory, through systematic ways of general sheets,unceasing, homogeneous and articulated, organized in agreement with the goverment priorities.



The major created products are :

. International Sheets of 1:1.000.000 scale.
. Topographics sheets in the following scales:

scale	methods
1:1.000.000	compilation
1:250.000	stereocompilation and compilation
1:100.000	stereocompilation
1:50.000	stereocompilation
1:25.000	stereocompilation

The position of the sistematic mapping of the Brazilian territory :

scale	total	% mapping
1:25.000	492	1,01
1:50.000	1647	13,9
1:100.000	2289	75,39
1:250.000	444	80,72
1:500.000	68	36,9
1:1.000.000	46	100,0

III) THE MAPPING OF THE TERRITORY REGIONS :

To depart from the topographic mapping it represents the Brazilian territories through maps specifically for each region of the country.

The created products are:

. The map of Brazil (The geographic scale - 1:2.500.000, 1:5.000.000, 1:10.000.000 and low scales)

. The Regional Maps (geographic scales).

. The Provincies Maps (geographic scales).

IV) CARTOGRAPHY DATABASE (M.T.D) AT THE IBGE:

At present the growing volume, diversity and the volatility of relevant information for the development in all sectors of the Brazilian society has determined that all companies involved in the establishement of policies and strategic planning of the systematic use of the natural country's resources, making use of instruments, methodologies and technologies which allow the analsys of integrated information and georeferencies.

In this manner we have noticed the crescent embodiment of technology of the geographic information system - GIS, for the production and diffusion of the information in several levels of the government and private enterprises.

The spatial components of the GIS system are the digital cartographic sheets in several scales and it becames urgent the transformation of the cartographic documents into digital database, together with descriptives information, will support several geographic analisys.

In this conversion we have to take into account the requirements, not used beforehand in drawings or in CAD's systems as well as the connection of network (hydrographic, roads, transmission and others) and the adjacensy and closing of polygonal elements. Through this prism the transposition cannot summarize the migration of the cartographic data digital enviroments, but also its topological structuture to facilitate the performance of some analisys.

In paralell with some projects still in assembly conventional production, the Cartographic Department acts creating basic conditions to convert the major sheets series and printed maps produced by the IBGE to digital cartographic database structured with topology requirements. This process started in 1990 with the World Bank approval of system datails to be acquired.

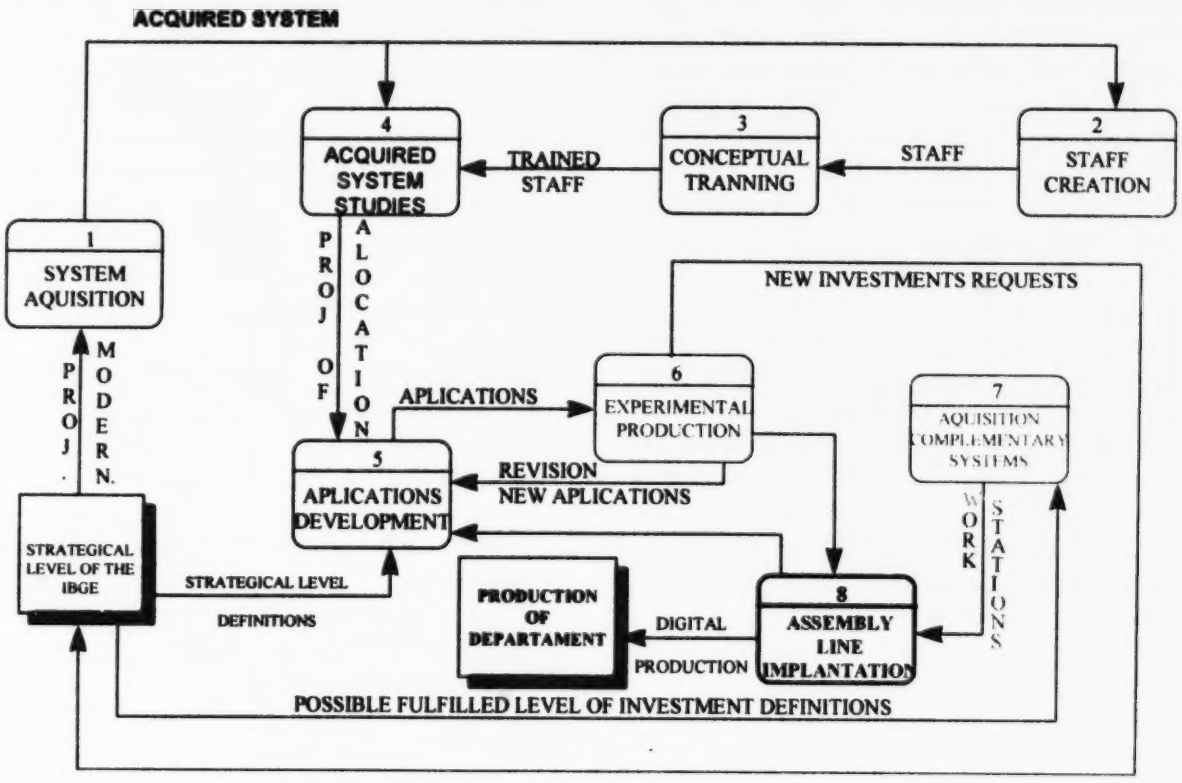
The development diagram of cartographic computerized was expanded as foreseen. Nowadays the project is in fase number eight of development diagram and the following steps are in the production area : Database Acquisition System by digital photogrametric stereocompilation; Structure and Database Management. We have started the pilot plant , in Cartographic updating with satellite images and radar images aerial.

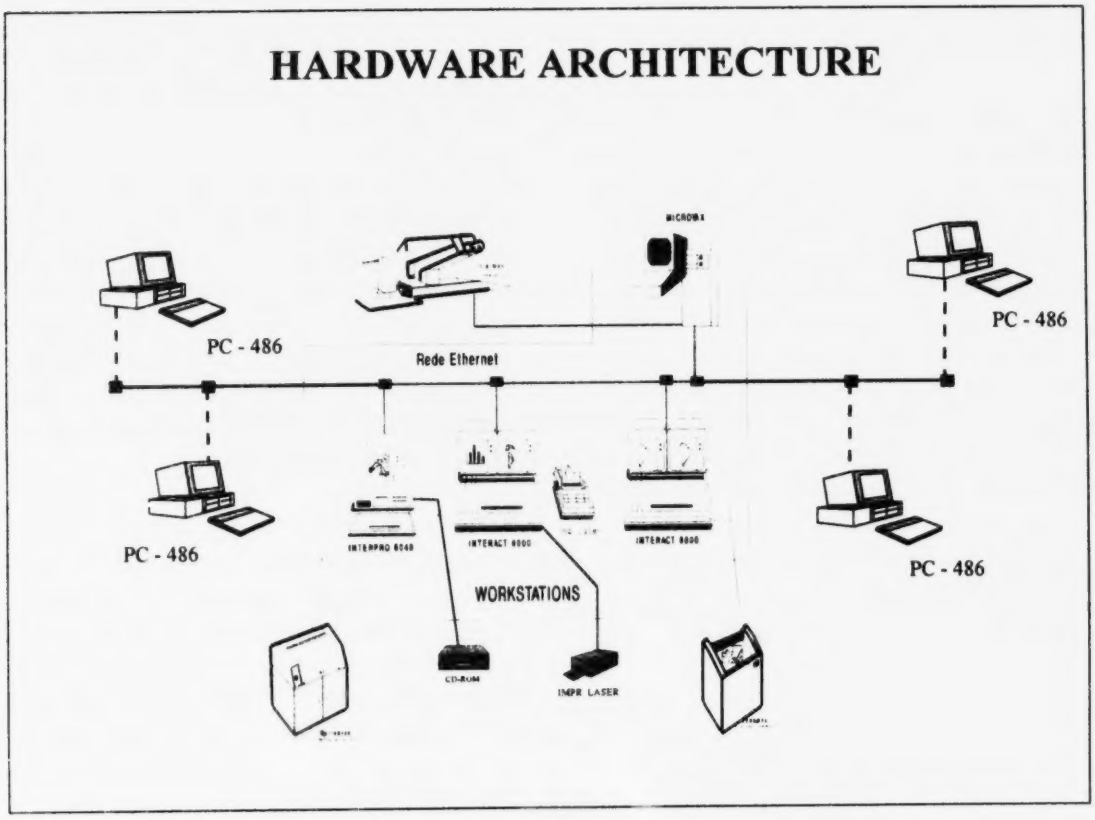
Throughout 1993 we had proceeded the adaptation of methodologies of some steps of the digital cartographic production through some projects of experimental production in the following areas: digital photogrametric stereocompilation, "digitalization" of positives by scanner; structured management and validation of MTD (Database cartographic); consolidation of the digital Municipal boundaries and automatic generation of cartographic positives.

The technological resources incorporated in the computerized project, formed this inicial step toward the modern cartographic. The assembly line was the following:

. Digital photogrametric stereocompilation system.
. Automatic digitalization system.
. Image Processing update system.
. Maps publishing system.

DIAGRAM OF DEVELOPMENT




HARDWARE ARCHITECTURE
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PC - 486
PC - 486
PC - 486
WORKSTATIONS
CD-ROM
IMPR LASER

V) CARTOGRAPHY COMPUTERIZED PROJECT

This cartographic database has been building from conversion of printed sheets, manual digitalization and stereocompilation, and will be the database information which describes the topographic reality of the country speaking of natural caracteristics as well as cultural.

The double purpose of this database is to grant the two principal as folowing:

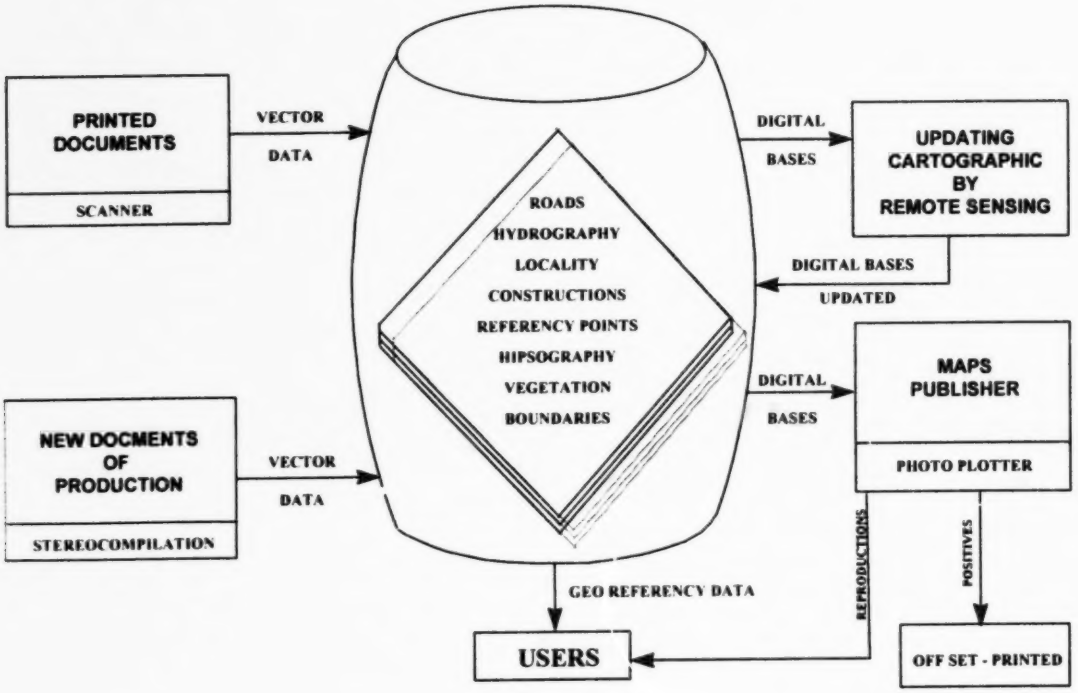
1) Scattering of digital cartoghaphic data for users, in order to serve as georeferences basis in Geographic Informatiom System.

2) Generation of updated cartographic products printed from the structure in database with guaranteed topology requirements.

Considering the activities at the IBGE that new approach will allow the integration of several informational classes, mainly information about natural resorces and social-economic, through geographic georeferency, embodied by national topographic reality acquired from the conversion of the sheets of the topographic mapping to digital database.

In brief, the internal projects which the cartographic database intends to support are: The national topographic mapping, municipal mapping which is the basis to collect data to census, prevision of harvest agriculture, Atlas production, Survey projects and mapping natural resources.

DATA BASE CARTOGRAPHIC



The cartographic database is structured into the next information categories:

1 - Hipsography
2 - Bounderies
3 - Control Points
4 - Hidrography
5 - Vegetation
6 - Locality
7 - Roads and Railroads
8 - Constructions

The objective of the first computerizing phase was how the development of some methodologies, normatizations and procedures to digital cartographic production and database shaping was obtained.

Throughout all these years of study and development it was possible to measure the term and expenses to execute some steps of the digital production, as well as revalidation of some specification, at first definited, in order to rush the development and the implantation of digital tecniques in assembly line. The phases of data publication in **raster format** and **data raster vectorization**, we migrated to PC's platforms linked in net.

VI) DESCRIPTION OF SOME PRODUCTS AVAILABLE IN DATABASE

1) The Digital State Map :

From the conversion of positives of the Millionth International sheet - (CIM), whose ending is forecast for the first term of 1997, new publications of state maps will be created, by compilation in digital environment of the states whose representation uses as supply the proportion 1:1.000.00.

2) The Digital Municipal Map :

The generation of some municipal maps in digital environment, depends on the topographic mapping conversion, in which the cooperation and articulation of governamental instituitions is primordial. The municipal map is the cartographic reference to census operational basis, and above them we have planned the census sectors to economic and social survey.

3) The Digital Photogrametric Stereocompilation:

Since 1993 the Carthographic Department is capable of creating in digital enviroment, by the photogrametric process, the topographic mapping sheets.

The machinery for the cartographic production is made up with six Wild B8 equipment and four KernPG2 equipment. Only the Wild B8 equipment repowered, and we are waiting for the PG2 repowering.

4) The Digital Municipal Boundary:

The Digital Municipal Boundary is made up of by the boundaries of politic-administrative division and were digitalized from the topographic mapping sheets. The municipal chart untill 1993 had 4974 provincies. From 1993 to 1997 were created more than 1600 provincies, and until may 1997 the municipal net must be updated. Availabe in CD-ROM in dxf, dgn and e00 format.

5) The Brazilian-Politic Map 1:5.000.000 scale:

From the digitalization of the cartographic positives of the Brazilian-politic map, is available in digital way. It is based on eight information categories of

cartographic database (MTD). Vehicled in CD-ROM dxf, dgn e e00 format.

6) The Environmental Diagnosis of the Legal Amazon:

The diagnosis is a Federal Government Program part of a general program called Ecological and Economic Zone. The program has got the main target to show a portrait of the area (covering the whole area of the Legal Amazon), speaking of the environment and the social-economic aspects and establish some planning procedures in macro scale.

The principal idea is to encourage the states to go on doing their own zone procedure and establisment of proper laws in consonence with the purpose in regional diagnosis. All information used in the diagnosis generation were converted to estructured digital ways for the use in Geographic Information System and has heralded for all prospective users.

The covered items are in 1:2.500.000 scale once the regional overspread the following items: cartographic base, geology, geomorphology, pedology, vegetation, the use of land, socio-economic aspects, antropism and preservation units (natural parks, native lands etc.) and hydrology.

7) The Brazilian Net of Continuous Monitoring (RBMC):

The IBGE launched the Brazilian Net of Continuous Monitoring and since may 1997 is available for users. There are nine GPS stations working twenty-four hours per day covering all country processing data.
The standard user will be able to connect the system in order get better data, accuracy, in terms of notes, saving money or time and cutting expenses.

VII) FINAL DISCUSSION:

The conversion of all mapping to digital environment is very expensive and the performance time is middle-term to long-term, and the conception and precision aquisition of the data are important factors which will define the fulfillment to Geographic Information System.

The cartographic bases at the IBGE was estructured to be used as spatial database in GIS.
To preserve the uniformity and quality of cartogaphy database at the IBGE (MTD), is necessary the development of applications to implementation the validation cartographic bases produced in others instituitions. The standartization and manners to interchange of cartography database some questions among others which need more discussions among productors and database cartographic users.
Nowadays this discuss has already started in The National Cartography Commission (CONCAR), this entity was brought back in 1997 and meets most of the instituitions which work with cartography in Brazil.
The conversion to digital environment and mapping updating, requests some efforts to cooperation and articulation betwen the IBGE and associates instituitions as well as expressive investments as much as in data production and cartographic basis interchange.
Nowadays we believe that projects like census 2000 year, The Vigilancy Amazon System (SIVAM Project) and the question of land reform, will lever in short-term updating of the cartography in Brazil.
At present there is at the IBGE a high consciousness to allocate new resources in projects of modernization and increase the cartographic digital production. About U$ 8,500.000.00 was allocated in 1997 and hope by 1998 the IBGE only will produce digital cartographic data in all its assembly lines.